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Directive 008

December 14, 2010
(formerly *Guide 8: Surface Casing Depth Minimum Requirements*)

Surface Casing Depth Requirements

The Energy Resources Conservation Board (ERCB/Board) has approved this directive on December 13, 2010.

<original signed by>

Dan McFadyen
Chairman

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1 Introduction

1.1 Purpose of the Directive

The Energy Resources Conservation Board (ERCB) *Directive 008* (formerly *Guide 8*) details the minimum surface casing depth requirements under the *Oil and Gas Conservation Regulations* (*OGCR*), Section 6.080, defines conditions required for setting deep surface casing, and provides additional requirements for specified areas in the province. The directive also sets out the conditions for exemption from the surface casing requirements and defines standards for conductor pipe.

This edition of *Directive 008* is effective immediately.

1.2 Requirements and Recommendations

ERCB requirements are identified throughout *Directive 008* and are numbered sequentially within each section in [square brackets] on the right side of the page, including in Section 2.2: Completing the Surface Casing Depth Calculation Form. The term "must" indicates a requirement, while "recommends" and "expects" indicate recommended practices.

1.3 What's New in the Directive?

Surface Casing Depth Calculation Form (Section 2.1): The calculation form (formerly the Surface Casing Check Sheet) has been modified to include the determination of water wells within 200 metres (m). Also, an option has been added for the calculation of surface casing depth based on the maximum pressure gradient to be encountered in the hole at a specific zone and depth. The deepest surface casing depth calculated must be used. The term "development-type setting" has been replaced by "established area" (see Appendix A for definition).

Deep Surface Casing (Section 2.4): This new section details surface casing requirements for depths greater than 650 m true vertical depth (TVD). It includes a change to the *OGCR*, Section 6.080(3), in which the surface casing depth is increased from 450 m to 650 m.

Specified Areas (Section 2.5): This section sets out the requirements that must be met if drilling in an area specified in Section 2.5 (formerly "special area").

Non-Thermal Injection and Disposal Wells (Section 2.6): This new section sets out the requirement that all non-thermal injection and disposal wells must have surface casing set.

Thermal Wells (Section 2.7): This new section sets out the requirement that thermal injection and production wells must have surface casing set.

Surface Casing Exemptions (Section 3): This section sets out the requirements for surface casing exemptions for wells drilled to a maximum depth of 1000 m TVD without a formal application. The area in which the requirements for surface casing exemption apply has been expanded to cover the entire province.

Surface Casing Set, Class I BOP Installed (Section 4): This new section sets out the requirements for using a Class I blowout preventer (BOP) system when surface casing has been set.

Conductor Pipe (Section 5): This section has been updated.

Water Flows (Section 6): This is a new section that includes the identification of water flows within a specified area and the wellbore requirements.

Compliance Assurance (Section 7): This section has been updated to reflect changes in *Directive 019: Compliance Assurance*.

Appendices: All the appendices have been updated. Appendix D is new and contains information on conductor hole and diverter line sizes. Appendix F is new and contains checklists.

2 Surface Casing Standards

Surface casing is an integral part of the well control system. It provides sufficient pressure integrity to facilitate the drilling of a well to total depth or to an intermediate casing point, whichever comes first, as well as primary support for the wellhead and the landing loads of subsequent casing and tubing strings. It may also be used to cover zones of caving, sloughing, and lost circulation, as well as other weak zones. Surface casing is a permanent structure of the wellbore that effectively protects in-use aquifers that supply domestic water wells.

Surface casing must be cemented in accordance with the requirements in *Directive 009: Casing Cementing Minimum Requirements*. [1]

Potentially toxic substances in the drilling fluids must not be used while drilling the surface hole (in accordance with *Directive 036: Drilling Blowout Prevention Requirements and Procedures*, Section 19.1). [2]

The basic assumptions for the calculation of surface casing depth are that

- a 3 cubic metre (m^3) kick can be circulated out of the hole without fracturing the casing shoe,
- the required pressure at the surface casing shoe is a linear relationship between 50% of the maximum bottomhole pressure for a well depth of 0 m TVD and 27.5% of the maximum bottomhole pressure for a well depth of 3600 m TVD (see Figure 1), and

- up to a maximum of 22 kilopascals per metre (kPa/m), the formation leak-off test is used to determine the fracture pressure at the shoe at 450 m, using a 10 kPa/m formation pressure gradient.

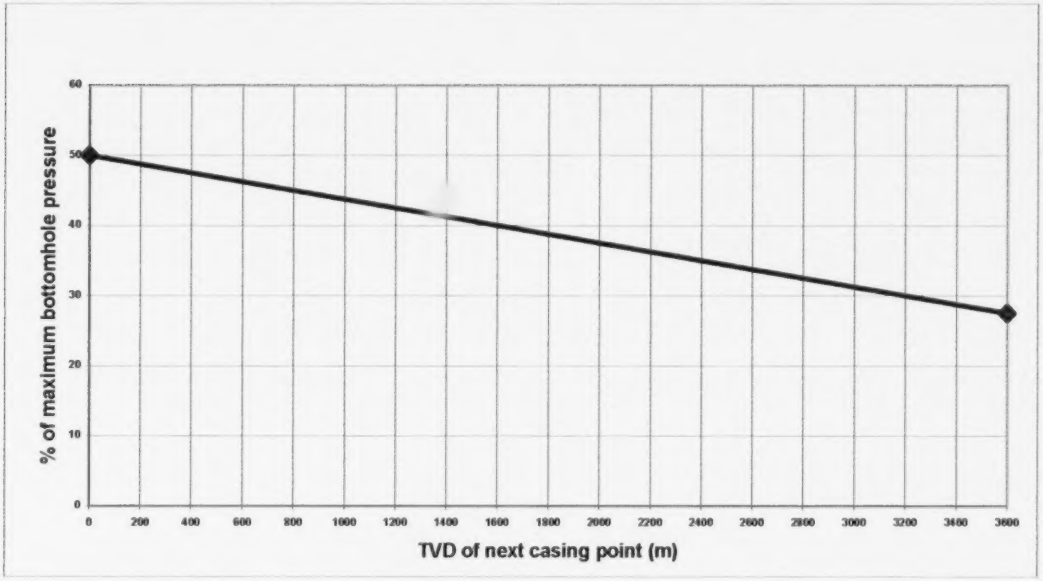

Figure 1. Percentage of maximum bottomhole pressure at the surface casing shoe

2.1 Surface Casing Depth Calculation Form

The Surface Casing Depth Calculation form is used to determine the amount of surface casing required and any reductions that are applicable. Section 2.2 provides detailed instructions on how to complete the form.

Surface casing must be designed in accordance with Section 2 and used in the well licence application (see *Directive 056: Energy Development Applications and Schedules*). [3]

ERCB Energy Resources Conservation Board

Directive 008
Surface Casing Depth Calculation

Specified Areas: See Section 2.5 if the well is in the Senex, Kidney, Trout, or associated areas; the high-hazard area of southeastern Alberta; or the surface mineable area.

UWI:_____ TVD:_____ KB ELEVATION: _____

PART I: WATER WELL SEARCH

A. Depth of deepest water well within 200 m: _____m TVD

B. Minimum surface casing depth required: [A] + 25 = _____ m TVD

PART II: SURFACE CASING REQUIRED

1. Representative pressure measurement in area: _____ kPa
2. Depth of pressure measurement: _____ m TVD
3. Reference well(s): _____/_____-_____-_____-_____W_____
4. Higher pressures were found but were discounted. ..... YES ☐ NO ☐

   Reason: _____
5. Maximum gradient: [1] ÷ [2] = _____ kPa/m
6. Surface casing (SC) depth required: _____ m TVD

   Option 1: Calculate surface casing depth.

   $$\text{SC depth} = \frac{\text{Maximum gradient} \times \text{TVD} \times (0.5 - 0.0000625\ \text{TVD})}{22\ \text{kPa/m}}$$

   Option 2: Calculate SC for each zone.

   $$\text{SC depth} = \frac{\text{Maximum gradient (at zone)} \times \text{TVD (at zone)} \times (0.5 - 0.0000625\ \text{TVD [at zone]})}{22\ \text{kPa/m}}$$
7. 10% of TVD = _____ m TVD
8. Surface casing depth required: _____ m TVD (must be the greater value of [B], [6], or [7])

If surface casing depth = [B], no surface casing reduction is allowed.

PART III: SURFACE CASING REDUCTION REQUIREMENTS

Type 1—Reduction for Wells Drilled with Well Control Enhancements

Surface casing depth required: _____ m TVD ([8] above)

Reduced surface casing depth: Surface casing depth x 0.913 = _____ m TVD (must be ≥[B])

Indicate which one of the following two options will be used:

1. A PVT system will be installed with a probe in each active drilling fluid compartment; the system will be accurate to ±0.5 m^3 and will alarm at ±2.0 m^3 ..... YES ☐ NO ☐
2. A formation leak-off test or a formation integrity test will be performed, in accordance with Appendix C ..... YES ☐ NO ☐

Type 2—Reduction for Low-Risk Wells

Surface casing depth required: _____ m TVD ([8] above)

Reduced surface casing depth: ([8] above) x 0.707 = _____ m TVD (must be ≥[B])

Indicate which of the following criteria will be met (at least three must be selected):

1. The well is in an established area (see Appendix A). ..... YES ☐ NO ☐

(continued on next page)

2. The well is low risk. ..... YES ☐ NO ☐
   - The field kick rate is less than 3% of wells drilled to a formation not exceeding the terminating formation of this well. ..... YES ☐ NO ☐
3. A PVT system will be installed with a probe in each active drilling fluid compartment; the system will be accurate to ±0.5 m^3 and will alarm at ±1.0 m^3 ..... YES ☐ NO ☐
4. A formation leak-off test or a formation integrity test will be performed, in accordance with Appendix C ..... YES ☐ NO ☐

Type 3—Reduction to Historical Setting Depth

Surface casing depth required: _____ m TVD (Part II[8])

Historical surface casing depth required: _____ m TVD (must be ≥[B])

Indicate if each of the following will be met:

1. The well is in an established area (see Appendix A). ..... YES ☐ NO ☐
2. The well is low risk.
   - The field kick rate is less than 3% of wells drilled to a formation not exceeding the terminating formation of this well ..... YES ☐ NO ☐
3. A PVT system will be installed with a probe in each active drilling fluid compartment; the system is sensitive to ±0.5 m^3 and will alarm at ±1.0 m^3. ..... YES ☐ NO ☐
4. A formation leak-off test or a formation integrity test will be performed, in accordance with Appendix C ..... YES ☐ NO ☐
5. An emergency flare line will be installed, in accordance with *Directive 036*. ..... YES ☐ NO ☐

Historical depth data: The historical depth requested is the same or greater than that set in the wells listed below.

Well Location	Total Depth (m)	Surface Casing (m)	Year

Type 4—Reduction to a Depth Above a Problem Zone

Surface casing depth required: _____ m TVD (Part II[8])

"Prognosed" top of problem zone: _____ m TVD

Name of problem zone: _____

Reason zone is a problem: _____

Surface casing depth proposed: _____ m TVD (must be ≥[B])

Indicate if each of the following will be met:

1. A PVT system will be installed with a probe in each active drilling fluid compartment; the system will be accurate to ±0.5 m^3 and will alarm at ±1.0 m^3. ..... YES ☐ NO ☐
2. A formation leak-off test or a formation integrity test will be performed, in accordance with Appendix C ..... YES ☐ NO ☐
3. An emergency flare line will be installed, in accordance with *Directive 036*. ..... YES ☐ NO ☐

PART IV: SURFACE CASING EXEMPTION (if applicable)

1. The licensee is not setting surface casing and meets the requirements in Section 3 ..... YES ☐ NO ☐

2.2 Completing the Surface Casing Depth Calculation Form

Part I: Water Well Search

A.	**Depth of deepest water well within 200 m**	Determine the depth of the deepest water well within a 200 m search area around the surface location of the proposed well.
B.	**Minimum surface casing depth required**	Calculate the minimum surface casing depth using the depth from (A) and adding 25 m. The minimum surface casing depth must be 25 m below the deepest water well within 200 m of the surface location of the proposed well. [4]

Part II: Surface Casing Required

1.	**Representative pressure measurement in area**	Determine the representative pressure measurement (kPa) from the wells in a 5 km search area around the surface location. Note: A search must also be conducted within 1 km of the surface location for water flows, springs, and flowing seismic shot holes, in accordance with Section 6. Option 1: Use the maximum pressure that may be encountered while drilling the proposed well (include pressure data from enhanced recovery schemes). • For a description of representative pressure measurements, see Appendix B. • If the well is in an area where there are insufficient pressure data, see (5) below. Option 2: Provide the representative pressure measurement (kPa) used to calculate the maximum gradient.
2.	**Depth of pressure measurement**	Provide the true vertical depth of the pressure measurement (m TVD).
3.	**Reference well(s)**	Provide the location of the reference well(s).
4.	**Higher pressures were found but discounted**	YES means higher pressures were found in the area but were discounted. If YES, state why. Supporting technical information (including data on the use of pressure gradients and leak-off gradients used in the calculations) must be kept on file in case of an audit. [5]
5.	**Maximum gradient**	Provide the maximum gradient (kPa/m). • Calculate the maximum gradient using the maximum pressure measurement in the area divided by the true vertical depth of the pressure measurement. Note: The maximum gradient may not occur using the maximum pressure, and a thorough review of pressures in the area may need to be completed to determine the maximum gradient.

- If a well is in an area where there are insufficient pressure data, use 11 kPa/m in the equation.

6. Surface casing depth required

Enter the surface casing (SC) depth required. Use Option 1 or 2 to calculate.

Option 1: Using the maximum gradient from (5), calculate the surface casing:

$$\text{SC depth} = \frac{\text{Maximum gradient} \times \text{TVD} \times (0.5 - 0.0000625\ \text{TVD})}{22\ \text{kPa/m}}$$

where TVD is the TVD of the first intermediate casing or the total depth of the well.

Option 2: In some instances the maximum gradient might occur above the planned TVD of the next casing string and may result in a deeper than necessary surface casing. In this case, to correctly calculate the required surface casing, the pressure gradient and depth of each zone must be used. Use the maximum gradient (5) and depth at each zone to calculate the surface casing:

$$\text{SC depth} = \frac{\text{Maximum gradient (at zone)} \times \text{TVD (at zone)} \times (0.5 - 0.0000625\ \text{TVD [at zone]})}{22\ \text{kPa/m}}$$

The maximum surface casing calculated must be used. |6|

If the leak-off gradient of an offset well is known and is less than 22 kPa/m, licensees should use the gradient from the leak-off test in the calculation. (Refer to Appendix C for formation leak-off test information.)

7. 10% of TVD

Calculate 10% of TVD.

8. Surface casing depth required

Use (B), (6), or (7), whichever is greater. This is the surface casing depth. |7|

The surface casing depth must be a minimum 25 m below the deepest water well within 200 m of the surface location of the proposed well. If (6) and (7) are greater than this, the surface casing must be set to a minimum of 10% TVD regardless of the pressure expected (unless surface casing is waived or reduced).

If a well is being drilled near a valley, the well design should include locating the well at a sufficient distance from the valley wall or setting surface casing at a sufficient depth below the base of the valley to prevent breakthrough to the valley during drilling operations.

If the planned surface casing setting depth terminates in an unconsolidated zone, drilling should continue until a competent zone is penetrated by at least 5 m.

The amount of surface casing required does not allow a well to be shut in indefinitely. The intent of a minimum shut-in period is to obtain stabilized shut-in pressures that will allow implementation of acceptable methods of well control, provided the surface casing is set in a competent zone (see the sections on well control methods in Enform's *First Line Supervisor's Blowout Prevention*).

Part III: Surface Casing Reduction Requirements

Four types of surface casing reductions are permitted, as outlined below, unless the wells are to be drilled in the areas specified in Section 2.5, in which case these reductions do not apply. Refer to Appendix B for background information about the reductions.

Reduced surface casing depth, regardless of the type of reduction, must be equal to or greater than the minimum surface casing depth calculated in Part I(B). [8]

Type 1—Reduction for Wells Drilled with Well Control Enhancement

Surface casing depth required

Enter the depth (m) from (8) in Part II.

Reduced surface casing depth

Multiply the normal surface casing depth required by a reduction factor of 0.913.

One of the following two options must be used to reduce the surface casing depth. Indicate which one will be used: [9]

1) a pit volume totalizer (PVT) system will be installed, accurate to $\pm 0.5\ m^3$ and sounding an alarm at $\pm 2.0\ m^3$, with a probe in every active drilling fluid compartment (see Appendix B), or
2) a formation leak-off test or a formation integrity test will be performed, in accordance with Appendix C, to determine the maximum allowable casing pressure and the maximum allowable TVD.

Type 2—Reduction for Low-Risk Wells

Surface casing depth required

Enter the depth (m) from (8) in Part II.

Reduced surface casing depth

Multiply the normal surface casing depth required by a reduction factor of 0.707.

At least three of the following criteria must be met to use the reduced surface casing depth. Indicate which criteria will be met: [10]

1) The well is in an established area (see Appendix A).

   Data and depths for offset wells within a 5 km radius must be available for audit upon request.

2) The well is low risk.

   The field kick rate (see Appendix B) is less than 3% of the wells drilled to a formation not exceeding the terminating formation of the proposed well.

3) A PVT system will be used, accurate to $\pm 0.5\ m^3$ and sounding an alarm at $+1.0\ m^3$, with a probe in every active drilling fluid compartment (see Appendix B).

4) A formation leak-off test or a formation integrity test will be performed, in accordance with Appendix C, to determine the maximum allowable casing pressure and the maximum allowable TVD.

Supporting documentation verifying the above must be available for audit upon request. [11]

Type 3—Reduction to Historical Setting Depth

Surface casing depth required

Enter the depth (m) from (8) in Part II.

Historical surface casing depth required

For wells drilled in established areas, normal surface casing may be decreased to the average setting depth in the area. For background information on historical setting depths, see Appendix B.

All of the following must be met to reduce the surface casing to the historical depth. Indicate if each one will be met: [12]

1) The well is in an establis[illegible]rea (see Appendix A).

   Data and depths for offset wells within a 5 km radius must be available for audit upon request. [13]

2) The well is low risk.

   The field kick rate is less than 3% of wells drilled to a formation not exceeding the terminating formation of the proposed well (see Appendix B).

3) A PVT system will be used, accurate to ±0.5 m^3 and sounding an alarm at ±0.5 m^3, with a probe in every active drilling fluid compartment (see Appendix B).

4) A formation leak-off test or a formation integrity test will be performed, in accordance with Appendix C, to determine the maximum allowable casing pressure and the maximum allowable TVD.

5) An emergency flare line will be installed, in accordance with *Directive 036*, Section 15.2.

Supporting documentation verifying the above must be available for audit upon request. [14]

Historic depth data

List the wells where surface casing was set to the depth applied for in this application. This list must be available for audit upon request. [15]

Type 4—Reduction to a Depth Above a Problem Zone

A type-4 reduction is suitable for wells drilled in areas where it is necessary to set surface casing immediately above a problem zone (such as in the Milk River area in southeastern Alberta) for the purposes of obtaining a high-quality cement job on the surface casing.

Surface casing depth required — Enter the depth (m) from (8) in Part II.

"Prognosed" top of problem zone — Enter the "prognosed" top of the problem zone (m).

Name of problem zone — Enter the name of the problem zone.

Reason zone is a problem — Provide the nature of the problem, e.g., lost circulation.

Surface casing depth proposed — Enter the proposed surface casing depth (m). This depth should be no more than 15 m above the prognosed top of a zone known to be a problem in the area and above any known hydrocarbon zones. A deeper problem zone will result in deeper surface casing being set.

All of the following must be met to use proposed surface casing depth. [16]
Indicate if each one will be met:

1) A PVT system will be installed, accurate to ± 0.5 m^3 and sounding an alarm at $+1.0$ m^3, with a probe in every active drilling fluid compartment (see Appendix B).
2) A formation leak-off test or a formation integrity test will be performed, in accordance with Appendix C, to determine the maximum allowable casing pressure and the maximum allowable TVD.
3) An emergency flare line will be installed, in accordance with *Directive 036*, Section 15.2.

Part IV: Surface Casing Exemption

Part IV is only filled out if the licensee is not setting surface casing. The licensee must then meet the requirements set out in Section 3 in order to submit a routine well application. If the licensee is not setting surface casing and the requirements in Section 3 are not met, the licensee must apply for an exemption and submit a nonroutine well application.

2.3 Surface Casing Set <650 m

Surface casing must be set in accordance with Sections 2.1 and 2.2. [17]

If the licensee is setting surface casing at a depth less than 650 m TVD, an application does not need to be submitted to the ERCB.

If a known hydrocarbon zone (see Appendix A) may be encountered above the surface casing setting depth, [18]

1) conductor pipe must be set in accordance with Section 5, and
2) a Class I BOP system (as defined in *Directive 036*, Appendix 3) must be installed.

If no known hydrocarbon zones are present, the licensee is not required to set conductor pipe or install a Class I BOP system.

2.4 Deep Surface Casing (>650 m)

If the licensee is setting surface casing deeper than 650 m TVD, although an application does not need to be submitted to the ERCB, the following must be met: [19]

1) Conductor pipe must be set in accordance with Section 5.
2) A gas detection device must be installed during the drilling of the surface hole.
3) A Class I BOP system (as defined in *Directive 036*, Appendix 3) must be installed.
4) Surface casing must be set a minimum of 50 m above the shallowest known hydrocarbon zone (see Appendix A for definition).
5) The field kick rate must be 0% to surface casing depth.
6) The offset wells (at least 5) within a minimum 5 km search radius down to the surface casing depth must meet the following:
   a) There are no blowouts (including water flows) in the proposed surface hole interval.
   b) There are no severe lost circulation incidents.
   c) There are no enhanced recovery schemes (conventional or thermal) in the area.
7) Requirements associated with the Surface Casing Depth Calculation form must be met.
8) There must be no water wells within a 200 m radius of the subject well.
9) Checklist 1 in Appendix F must be completed and available at the well site. Multiple wells can be included on an attached list. All requirements must be met for each well.

Supporting documentation verifying the above must be available for auditing purposes. [20]

2.4.1 Reporting Requirements

If a well control incident (kick) occurs while drilling the surface hole, the licensee must report the following information to the appropriate ERCB Field Centre immediately: [21]

- well location,
- time and date of occurrence,
- depth, kick volume, and final drilling fluid weight to control occurrence,
- duration, and
- licensee contact (name and phone number).

Upon consultation with ERCB Well Operations, surface casing may need to be set at a shallower depth than planned.

The licensee must also meet the reporting requirements in *Directive 059: Well Drilling and Completion Data Filing Requirements*. [22]

2.5 Specified Areas

If a proposed well is in one of the areas specified in this section, the surface casing must be set in accordance with the minimum requirements. [23]

2.5.1 Senex, Kidney, Trout, and Associated Areas

Senex, Kidney, Trout, and associated areas are within

- Townships 86 to 90, Ranges 1 to 6, west of the 5th Meridian, and
- the north half of Township 90 to Township 99, Range 1 to the east half of Range 14, west of the 5th Meridian (see Figure 2).

Refer to the following for additional requirements:

- *Interim Directive (ID) 91-06: Casing, Cementing, Sampling and Logging Requirements, Senex, Kidney, Trout, and Associated Areas* sets out the casing, cementing, sampling, and logging requirements for these areas.
- *Directive 009: Casing Cementing Minimum Requirements* presents the minimum requirements for casing cementing.
- *Directive 020: Well Abandonment* provides the minimum abandonment requirements.

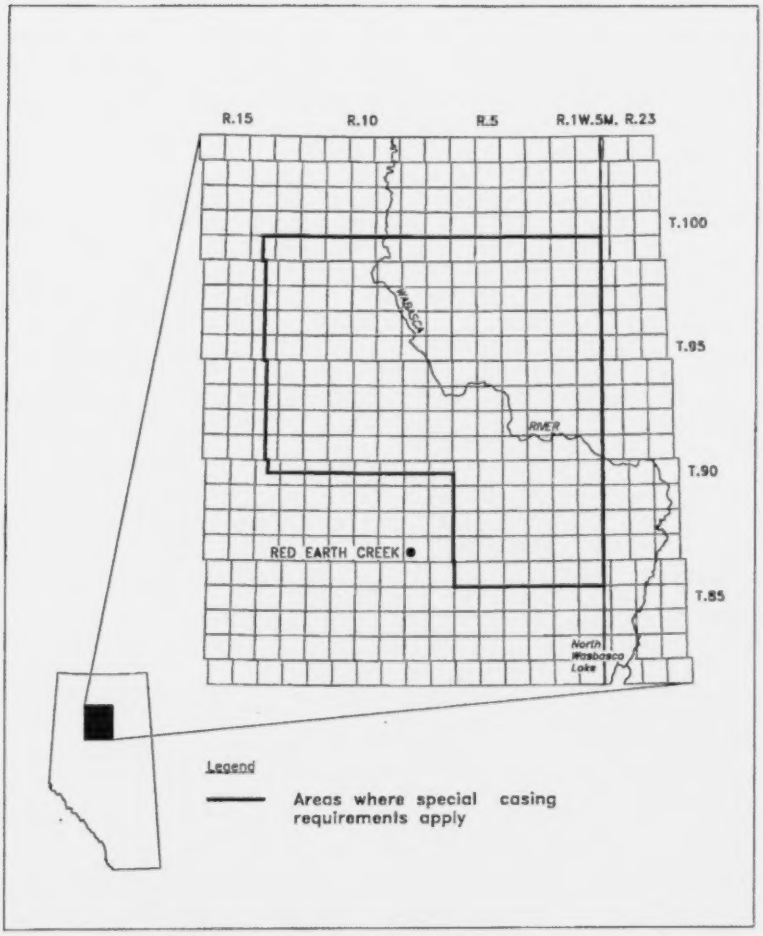

Figure 2. Senex, Kidney, Trout, and associated areas

2.5.2 High-Hazard Area of Southeastern Alberta

Directive 036, Section 15, defines the area within Townships 19 to 24, Ranges 5 to 10, West of the 4th Meridian, as a high-hazard area (see Figure 3) and sets out the requirements for wells drilled in this area.

A minimum of 180 m of surface casing must be set if the well penetrates the Mannville Group. [24]

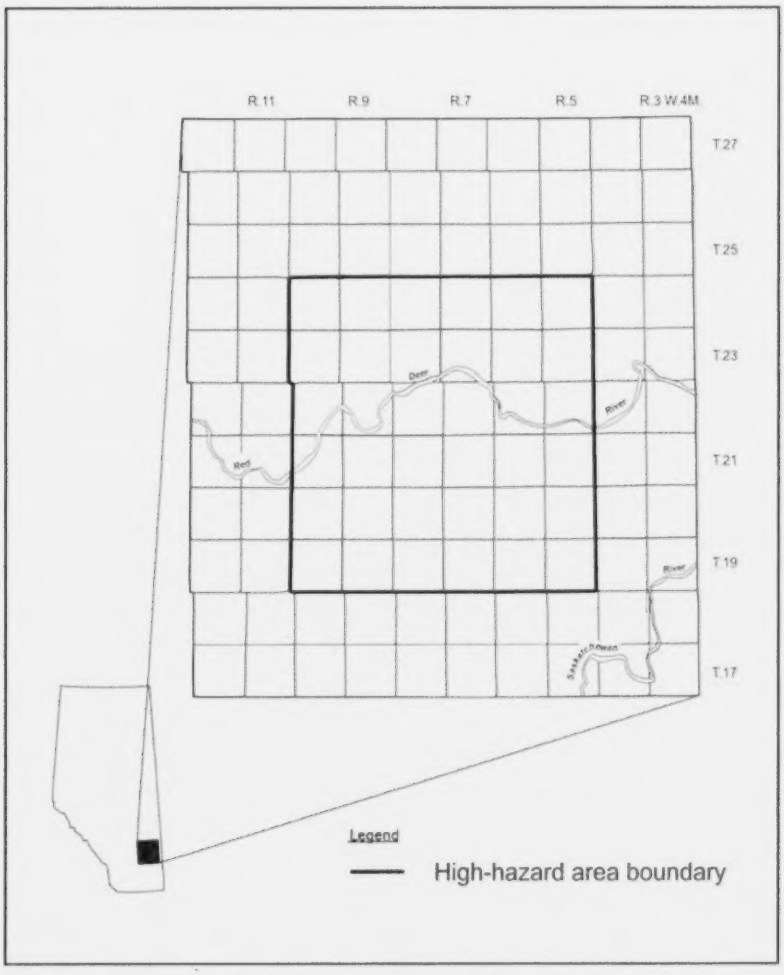

Figure 3. High-hazard area of southeastern Alberta

2.5.3 Surface Mineable Area (Oil Sands Core Holes and Oil Sands Evaluation Wells)

The following applies to oil sands core holes and oil sands evaluation wells only.

For wells not deeper than 200 m TVD and inside the surface mineable area, surface casing is not required if conductor pipe is set into a competent formation. *Directive 036*, Section 21, sets out the minimum requirements with respect to blowout prevention practices and the equipment needed for drilling oil sands core holes and oil sands evaluation wells that are no deeper than 200 m within the surface mineable area (see Figure 4).

Core holes and oil sand evaluation wells not exceeding 200 m TVD and within 10 km of the surface mineable area may conform to the same blowout prevention and drilling practices as inside the surface mineable area.

Wells deeper than 200 m or 10 km outside of the surface mineable area must follow the requirements of this directive for minimum surface casing. [25]

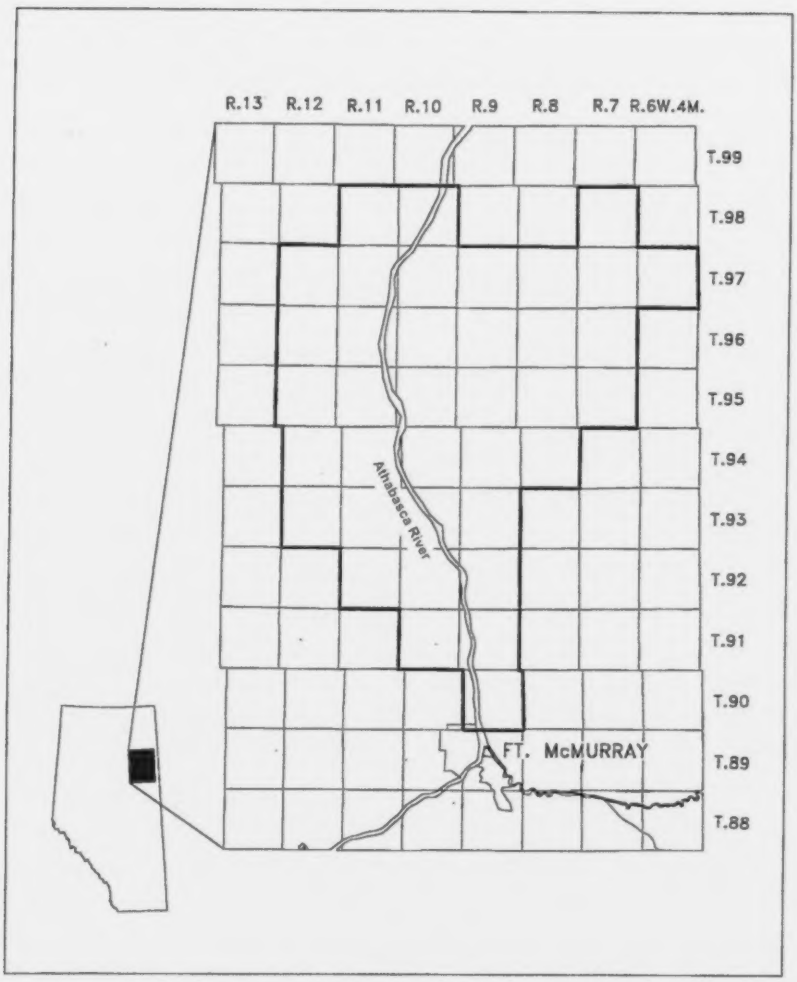

Figure 4. Surface mineable oil sands area

2.6 Non-Thermal Injection and Disposal Wells

Surface casing depths of non-thermal injection and disposal wells must meet the requirements of Section 2.1 and *Directive 051: Injection and Disposal Wells*. [26]

Injection wells associated with solution mining, storage, or disposal caverns must have surface casing set and the surface casing depth must be to the base of groundwater protection. [27]

2.7 Thermal Wells

Thermal injection and production wells must have surface casing set. The surface casing depth must meet the requirements of *Directive 051*, the scheme approval conditions (*Directive 023: Guidelines Respecting an Application for a Commercial Crude Bitumen Recovery and Upgrading Project*), and any additional requirements set by the ERCB. These conditions and requirements are designed to protect groundwater, and the depth for surface casing should be based on the geological setting. [28]

3 Surface Casing Exemptions

This section details the requirements that must be met when surface casing is not set. Surface casing exemptions do not apply to thermal wells (see Section 2.7).

The following criteria must be met for surface casing exemption without ERCB approval: [29]

1) The well must terminate at 1000 m TVD or less.

2) Conductor pipe must be set in accordance with Section 5.

3) A Class I BOP system (as defined in *Directive 036*, Appendix 3) must be installed.

4) The diverter line must terminate in a flare tank. (Flare tanks must meet the requirements in *Directive 036*, Section 2.4.)

5) The well must be drilled in an established area (see Appendix A for definition).

6) The bottomhole of the well must be located a minimum of

   a) 300 m away from the closest bottomhole location of an existing steam-assisted gravity drainage (SAGD) well,

   b) 1000 m away from the closest bottomhole location of an existing cyclic steam stimulation (CSS) well, and

   c) 1000 m away from a non-thermal enhanced recovery scheme well.

7) The offset wells within a 3 km search radius must meet the following:

   a) The kick rate is 0%.

   b) There are no blowouts (water flows included).

   c) There are no severe lost circulation incidents.

   d) The maximum pressure gradient of any formation does not exceed 10 kPa/m.

   e) The estimated unstimulated absolute open flow potential (AOFP) does not exceed 113 10^3 m^3/day.

   f) There is no hydrogen sulphide (H_2S) present (0.0000 moles per kilomole [mol/kmol] H_2S).

8) There must be no water wells within a 200 m radius of the subject well.

9) Checklist 2 in Appendix F must be completed and available at the well site. For multiple wells, the checklist must be completed for each well or a well list must be attached to the checklist. All of the above criteria must be met for each well.

Supporting documentation verifying the above must be available for auditing purposes. [30]

If the above requirements are met, the well licence application should be submitted as routine.

An application for a surface casing exemption must address all the items listed in *Directive 056*, Section 7.10.10, and must provide the reason why the criteria above are not met. [31]

The licensee must indicate on Schedule 4 of *Directive 056* that the requirements of *Directive 008* are not met and submit the well licence application as nonroutine. [32]

3.1 Reporting Requirements

If a well control incident (kick) occurs while drilling the well, the licensee must report the following information to the appropriate ERCB Field Centre immediately: [33]

- well location,
- time and date of occurrence,
- depth, kick volume, and final drilling fluid weight to control occurrence,
- duration, and
- licensee contact (name and phone number).

Upon consultation with ERCB Well Operations, surface casing may need to be set on future wells.

The licensee must also meet the reporting requirements in *Directive 059: Well Drilling and Completion Data Filing Requirements*. [34]

4 Surface Casing Set, Class I BOP Installed

The following criteria must be met if a Class I BOP system is to be used after surface casing is set. No ERCB approval is required. [35]

1) The well must terminate at 1000 m TVD or less.

2) Surface casing must
   a) be set in accordance with the well licence, and
   b) meet *Directive 010: Minimum Casing Design Requirements*.

3) The diverter line must terminate in a flare tank. (Flare tanks must meet the requirements of *Directive 036*, Section 2.4.)

4) The well must be drilled in an established area (see Appendix A for definition).

5) The bottomhole of the well must be located a minimum of
   a) 300 m away from the closest bottomhole location of an existing SAGD well,
   b) 1000 m away from the closest bottomhole location of an existing CSS well, and
   c) 1000 m away from a non-thermal enhanced recovery scheme well.

6) The offset wells within a 3 km search radius must meet the following:

   a) The kick rate is 0%.

   b) There are no blowouts (water flows included).

   c) There are no severe lost circulation incidents.

   d) The estimated unstimulated AOFP does not exceed 113 10^3 m^3/day.

   e) The maximum pressure gradient of any formation does not exceed 10 kPa/m.

   f) There is no H_2S present (0.0000 mol/kmol H_2S).

7) The surface casing must be set 25 m deeper than any water wells within a 200 m radius of the subject well.

8) Checklist 3 in Appendix F must be completed and available at the well site. For multiple wells, the checklist must be completed for each well or a well list must be attached to the checklist. All of the above criteria must be met for each well.

Surface casing depth calculation (see Section 2) is not required.

Supporting documentation verifying the above must be available for auditing purposes. [36]

4.1 Reporting Requirements

If a well control incident (kick) occurs while drilling a well with a Class I BOP system, the licensee must report the following information to the appropriate ERCB Field Centre immediately: [37]

- well location,
- time and date of occurrence,
- depth, kick volume, and final mud weight to control occurrence,
- duration, and
- licensee contact (name and phone number).

Upon consultation with ERCB Well Operations, the appropriate class of BOP may need to be installed on the next well.

The licensee must also meet the reporting requirements in *Directive 059*. [38]

5 Conductor Pipe

If required for well control, the depth of the conductor pipe must be between 20 to 30 m, set into a competent zone, cemented full length by the forward circulation method, and meet the requirements of *Directive 009*. (See *Directive 008*, Appendix D, for suggested conductor and diverter line configurations.) Setting conductor pipe does not replace the need for surface casing unless the requirements for surface casing exemption have been met (see Section 3). [39]

Conductor pipe and a Class I BOP system must be used if [40]

- a search of wells within 1 km indicates water flows, or
- there are springs and/or flowing seismic shot holes (see Alberta Environment water well database) within 1 km.

For wells located within 100 m of a water body, using conducter pipe and a Class I BOP system should be evaluated as a mitigative measure in conjunction with assessing and addressing site sensitivities, as required by *Directive 056*.

Wells with conductor pipe set beyond 30 m (to find a competent zone) will be considered surface casing and must meet all regulatory requirements associated with surface casing. [41]

6 Water Flows

If an uncontrolled water flow[1] is encountered (a blowout, as defined in *Directive 036*), [42]

- the blowout must be reported to the ERCB Field Centre,
- a risk assessment must be conducted to determine if an additional string of casing is required, and
- approval must be obtained from the ERCB Field Centre before the licensee proceeds with drilling operations.

Note: Reporting requirements for blowouts are set out in *Directives 036* and *059*.

The ERCB expects licensees to take precautions to ensure that the water flow is controlled and the aquifer is protected during the drilling operation.

7 Compliance Assurance

The ERCB will enforce the requirements in this directive in accordance with *Directive 019: Compliance Assurance*. A list of risk-assessed noncompliances is available on the ERCB Web site at www.ercb.ca under Industry Zone : Compliance and Enforcement : Risk Assessed Noncompliance.

[1] See Appendix A for definition of water flow.

Appendix A Definitions for the Purposes of *Directive 008*

Absolute Open Flow Potential (AOFP)	Unstimulated, stabilized sandface absolute open flow potential.
Conductor pipe	Pipe used to keep the wellbore open and to provide a means of conveying the drilling fluid flowing up from the wellbore to the rig tanks and, if required for well control purposes, to accommodate a diverter system. (See Appendix D for recommended conductor and diverter line sizes.)
Established area (formerly development-type setting)	An area that has a minimum of three offset wells, each in a different direction, and a bottomhole location within 1.5 km of the proposed well. The offset wells must be drilled to the same formation, or deeper, than the proposed well(s).
Known hydrocarbon zone	Any zone in a well within a 5 km search radius of the proposed well that has produced or is producing hydrocarbons and has been reported to the ERCB.
Pit volume totalizer (PVT) system	A drilling fluid volume monitoring device installed at a drilling rig.
Severe lost circulation	The loss of more than 75 m^3 of drilling fluid from the wellbore into a permeable formation or more than 48 hours to control the lost circulation.
Surface casing	The first string of casing that is set in a well (unless conductor pipe is set). It provides structural integrity to support the BOP system and subsequent tubulars run in the well and has sufficient pressure integrity to facilitate well control. Surface casing is an integral part of the well control system.
Thermal well	A well that penetrates a reservoir that is, was, or has the potential to be artificially heated.
Water body	Refer to the current edition of *Directive 056* for a definition.
Water flow	Any flow of water from an aquifer that is encountered while drilling a well.

The following definitions are taken from the February 2006 edition of *Directive 036*. The ERCB expects licensees to use the definitions from the edition of *Directive 036* currently in effect.

Blowout	A blowout is a well where there is an unintended flow of wellbore fluids (oil, gas, water, or other substance) at surface that cannot be controlled by existing wellhead and/or blowout prevention equipment, or a well that is flowing from one formation to another formation(s) (underground blowout) that cannot be controlled by increasing the fluid density. Control can only be regained by installing additional and/or replacing existing wellhead and/or blowout prevention equipment to allow shut-in or to permit the circulation of control fluids, or by drilling a relief well.
Kick	A kick is any unintended entry of water, gas, oil, or other formation fluid into a wellbore that is under control and can be circulated out.

Appendix B Background Information

B1 Background Information for Section 2.1, Part II

B1.1 Representative Pressure Measurements

To obtain representative pressure measurements when drilling outside known pools, use the maximum test pressures in the area; when drilling inside of a known pool, use current bottomhole pressure measurements, especially for pools subject to enhanced recovery or pools depleted through extensive production. Wherever you choose to use depleted pressures to calculate surface casing setting depth, you must have supporting geological information down to and including the terminating formation. This information must be available in case of audit to confirm that the subject well will be within the known pool in question.

B1.2 Methods of Determining Maximum Pressures

- Drillstem test or other acceptable openhole methods
- Absolute open flow potential (AOFP) test pressures
- Pressure buildup
- Static pressure gradient
- Acoustic well sounder survey

B1.3 PVT System for Type-1 Reduction

For wells drilled with a PVT system accurate to within $\pm 0.5\ m^3$ and sounding an alarm at $\pm 2.0\ m^3$, you may apply a general reduction factor to the surface casing required in Section 2.1, Part II (8). The PVT system must be installed with a probe in every active drilling fluid compartment.

Kick tolerance theory shows that the surface casing required is proportional to the square root of the initial kick volume. The surface casing required in Section 2.1, Part II(8) has been found sufficient for circulation of a $3.0\ m^3$ kick (assumed to be a maximum volume before well control action is initiated). Where you use PVT systems during drilling operations, it is reasonable to assume that initial kick volumes can be limited to $2.5\ m^3$ if the system is preset to sound an alarm at $\pm 2.0\ m^3$. You may apply the following reduction factor to the surface casing required in Section 2.1, Part II(8):

$$(2.5\ m^3/3.0\ m^3)^{1/2} = 0.913$$

B1.4 PVT System for Type-2 Reduction

For low-risk wells in an established area drilled with a PVT system accurate to $\pm 0.5\ m^3$ and sounding an alarm at $\pm 1.0\ m^3$, you may apply the following reduction factor to the surface casing required in Section 2.1, Part II(8):

$$(1.5\ m^3/3.0\ m^3)^{1/2} = 0.707$$

This assumes that the initial kick volume can be limited to $1.5\ m^3$ if the alarm is preset to sound at $1.0\ m^3$.

B1.4.1 Historical Setting Depth

If a reduction in surface casing depth that is greater than a type-2 reduction results in insufficient casing to control the well using a method like the Drillers Method, a Low Choke or Modified Low Choke method must be used. Since these two methods put added pressure on the bleed-off system, an emergency flare line is required. These methods are described in Enform's *First Line Supervisor's Blowout Prevention*.

B1.5 Field Kick Rate

A 3% field kick rate is based on previous versions of *Directive 008*, which stated a field kick rate of 3 per 100 wells. Field counts of less than 100 wells are acceptable to calculate the field kick rate if the requirement for an established area is met.

Appendix C Formation Integrity Test and Formation Leak-off Test

The formation leak-off test results from the nearest offsetting wells, if known and less than 22 kPa/m, should be used in the equation to calculate the surface casing depth required (Section 2).

Figures C1 and C2 show the effects of the formation pressure gradient and a formation leak-off test result lower than 22 kPa/m on surface casing setting depth.

Figure C1 shows the effect of the formation pressure gradient on surface casing depth assuming that the pressure integrity test gradient is 16 kPa/m.

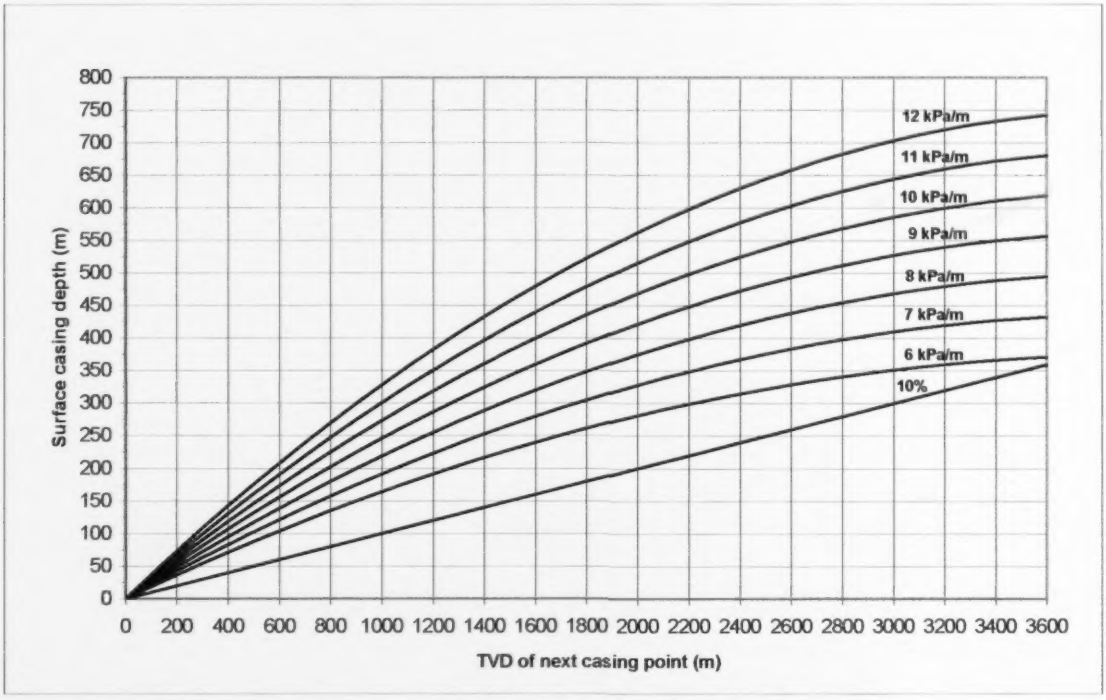

Figure C1. Effects of maximum surface casing depth for 16 kPa/m pressure integrity test (PIT) using different formation pressure gradients

Figure C2 shows the effect of the formation pressure gradient on surface casing depth assuming that the pressure integrity test gradient is 22 kPa/m.

Procedure

The integrity of the formation at a casing seat or in the open hole is a key factor during well control operations. The integrity of the formation can be determined by conducting a PIT. A formation leak-off test (FLOT) is a form of PIT conducted to the point of fracture initiation in the wellbore. A formation integrity test is a form of PIT conducted to a predetermined pressure set at some point below the fracture initiation pressure. The maximum allowable casing pressure can be determined by testing the integrity at the surface casing seat. The ERCB supports the concept of conducting a test at all wells due to the variability of PIT results.

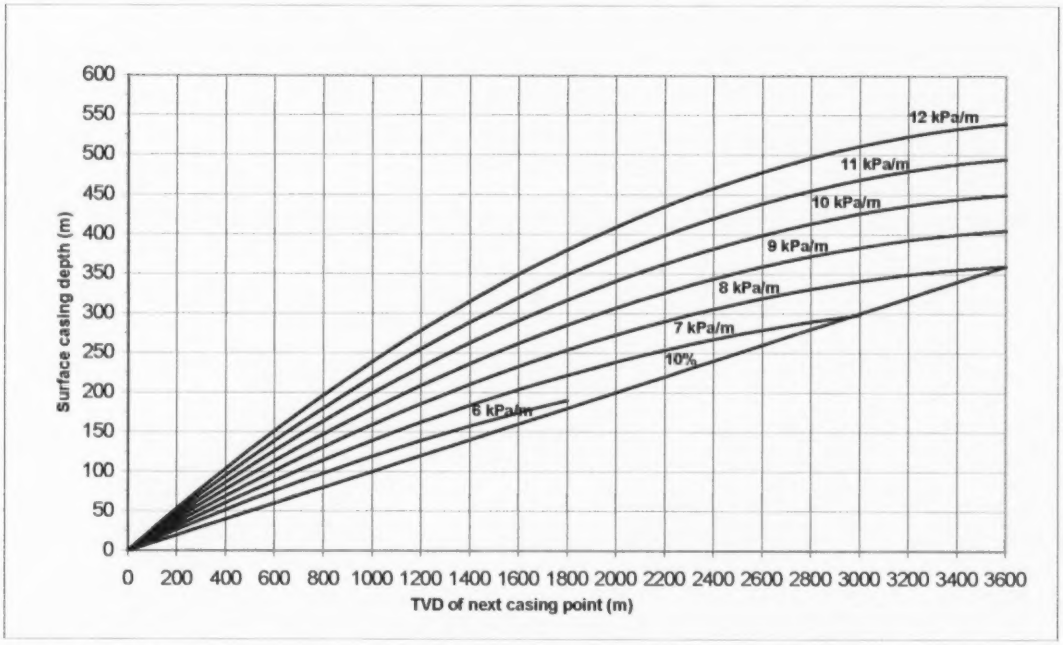

Figure C2. Effects of maximum surface casing depth for 22 kPa/m PIT using different formation pressure gradients

The recommended test procedure and reporting requirement for FLOTs (with 1000 litres [L] = 1 cubic metre [m^3]) are as follows:

1) Use a low-volume, high-pressure pump capable of pumping steadily and consistently at rates as low as 4 L/minute.

2) Drill at least 5 m, but not more than 10 m, below the surface casing shoe.

3) Pull up off bottom and fill hole.

4) Close blowout preventers. Ensure that the system is free of leaks.

5) Start pumping slowly at a consistent rate of about 4 to 8 L/minute, depending on the setting depth of the casing. (Pumping down both the annulus and drill pipe is preferable.)

6) Record pressure after every 4 L pumped, if possible.

7) Plot pressure against volume injected during the pumping, not afterwards (see Figure C3).

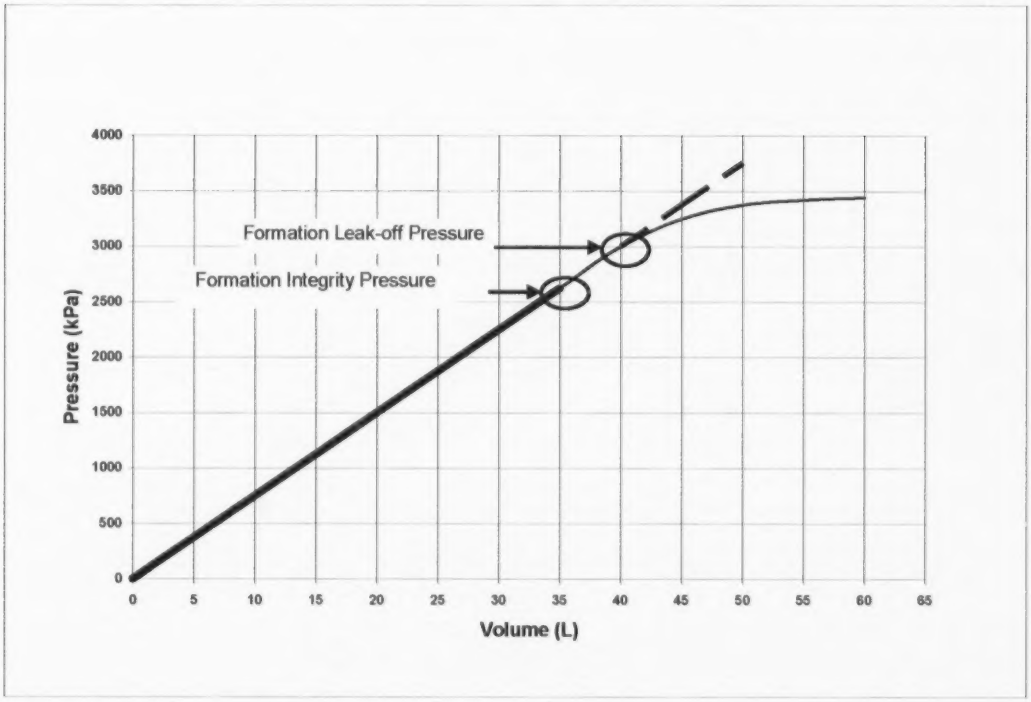

Figure C3. PIT pressure versus volume plot

8) Do not use a rig drilling fluid pump for performing a PIT at the shoe of the surface casing. The pump must be low volume, high pressure, and instrumented to accurately record and display the volume pumped and surface pressure as the test is being performed to determine the proper point at which to terminate the test. A linear pressure volume chart is preferable.

9) Record results on a calculation sheet and retain the information. Do not submit this information to the ERCB unless requested to do so.

Appendix D Conductor Pipe Sizes / Diverter Line Sizes

When drilling with only conductor set and a Class I BOP system, the table below can be used as a guide to determine the required conductor size and diverter line size to reduce the risk of flow to surface on the outside of the casing during an unanticipated flow from the wellbore.

Table D1. Recommended conductor pipe and diverter line sizes

Conductor size (Nominal) mm (in)	**Diverter line size** (Nominal) mm (in)	**Kill pump rate** m^3/min	**Drill collar size** mm	**Hole size** mm
177.8 (7)*	152.0 (6)	1.0	120	152
203.0 (8)	152.0 (6)	1.0	120	152
273.0 (10)	152.0 (6)	1.7	177	215
406.4 (16)	177.8 (7)*	3.3	229	311
508.0 (20)	203.0 (8)	5.5	229	444

* 177.8 mm (7") casing not recommended; pressure drop too great in conductor pipe/drill collar annulus and diverter line unless the assumptions below are revised; use 193.7 mm (7-5/8") casing or 203.0 mm (8") nominal pipe.

Assumptions

1. Gas flow rate approximately 90 10^3 m^3.
2. Low choke method used in accordance with Enform's *First Line Supervisor's Blowout Prevention*.
3. Kill pump rate approximately 35% above normal pump rate (annular velocity approximately 40 m/min).
4. Specific gravity gas 0.65.
5. Drilling fluid weight 1100 kg/m^3.
6. Two-phase flow program (Beggs & Brill) used to calculate pressure drop.
7. Drill collars through entire length of conductor.
8. Conductor set at 20 m below ground level, diverter close to ground level.

(Adapted from *API RP 64: Recommended Practices for Diverter Systems Equipment and Operations*)

Appendix E References

ERCB Documents

Directive 009: Casing Cementing Minimum Requirements
Directive 019: Compliance Assurance
Directive 020: Well Abandonment
Directive 023: Guidelines Respecting an Application for a Commercial Crude Bitumen Recovery and Upgrading Project
Directive 034: Gas Well Testing, Theory and Practice
Directive 036: Drilling Blowout Prevention Requirements and Procedures
Directive 043: Well Logging Requirements—Surface Casing Interval
Directive 051: Injection and Disposal Wells
Directive 056: Energy Development Applications and Schedules
Directive 059: Well Drilling and Completion Filing Requirements
Interim Directive (ID) 91-03: Heavy Oil/Oil Sands Operations
Oil and Gas Conservation Act
Oil and Gas Conservation Regulations
Base of Groundwater Protection Query Tool (ERCB Web site www.ercb.ca under Industry Zone : Data Submission and Reporting : ERCB: Reports : Base Groundwater Protection)

Alberta Environment

Alberta Environment Groundwater Information System (www.envinfo.gov.ab.ca/GroundWater/)

Enform Document

First Line Supervisor's Blowout Prevention (sections on well control methods)

API Document

API RP 64: Recommended Practices for Diverter Systems Equipment and Operations

Miscellaneous

Findings of the Committee on Surface Casing Requirements in the Lindbergh/Elk Point Area
Shallow Gas Well Completion Flare Line Length and Flare Height Review (commissioned by Pan Canadian) (available in the ERCB library)

Appendix F Checklists

ERCB Energy Resources Conservation Board

Directive 008, Checklist 1
Deep Surface Casing—No Application Required

The following checklist must be available at the well site. Supporting documentation confirming that the requirements have been met must be available for auditing purposes. An attached list showing multiple wells must contain the licence numbers, surface locations, and surface casing depths of the wells. Requirements must be met for each well. (Answers in bold indicate requirements.)

Name of licensee: _____ BA code: _____

Contact name: _____ Title: _____

Phone number: _____ E-mail address: _____

Well Licence No.: _____

Surface location of well: _____

Licensed surface casing depth: _____ mKB

1. Will conductor pipe be set in accordance with Section 5? ..... **YES** ☐ NO ☐

2. Will a gas detection device be installed during the drilling of the surface hole? ..... **YES** ☐ NO ☐

3. Will a Class I BOP system (as defined in *Directive 036*, Appendix 3) be installed? ..... **YES** ☐ NO ☐

4. Will the surface casing be set a minimum 50 m above the shallowest hydrocarbon zone? ..... **YES** ☐ NO ☐

5. Is the field kick rate 0% to the surface casing depth? ..... **YES** ☐ NO ☐

6. Regarding the offsetting wells within a minimum 5 km search radius down to the surface casing depth:

   a) Are there any blowouts (including water flows)? ..... YES ☐ **NO** ☐

   b) Are there are any severe lost circulation incidents? ..... YES ☐ **NO** ☐

   c) Are there any enhanced recovery schemes (conventional or thermal) in the area? ..... YES ☐ **NO** ☐

7. Have the requirements in the Surface Casing Depth Calculation form been met? ..... **YES** ☐ NO ☐

8. Are there water wells within a 200 m radius of the subject well? ..... YES ☐ **NO** ☐

Certification

I hereby certify that the information given is correct, that it has been provided by personnel taking responsibility for these commitments, and that the requirements set out in Section 2.4 of *Directive 008* have been met.

Print Name: _____ Title: _____

Signature: _____ Date: _____

ERCB Energy Resources Conservation Board

Directive 008, Checklist 2
Surface Casing Exemption

The following checklist must be available at the well site. Supporting documentation confirming that the requirements have been met must be available for auditing purposes. An attached list showing multiple wells must contain the licence numbers, surface locations, and terminating depths of the wells. Requirements must be met for each well. (Answers in bold indicate requirements.)

Name of licensee: _____ BA code: _____

Contact name: _____ Title: _____

Phone number: _____ E-mail address: _____

Well Licence No.: _____

Surface location of well: _____

1. The well will terminate at _____ m TVD
   (The terminating depth of the well must be less than 1000 m TVD.)
2. Will conductor pipe be set in accordance with Section 5? ..... **YES** ☐ NO ☐
3. Will a Class I BOP system (as defined in *Directive 036*, Appendix 3) be installed? ..... **YES** ☐ NO ☐
4. Will the diverter line terminate in a flare tank? ..... **YES** ☐ NO ☐
   (Flare tanks must meet the requirements of *Directive 036*, Section 2.4.)
5. Will the well be drilled in an established area? ..... **YES** ☐ NO ☐
6. Is the well located a minimum of 300 m away from an existing SAGD well, or 1000 m away from an existing CSS well or a non-thermal enhanced recovery scheme well? (These distances are closest bottomhole location to closest bottomhole location.) ..... **YES** ☐ NO ☐
7. Regarding the offsetting wells within a minimum 3 km search radius:
   a) Is the kick rate 0%? ..... **YES** ☐ NO ☐
   b) Are there any blowouts (including water flows)? ..... YES ☐ **NO** ☐
   c) Are there are any severe lost circulation incidents? ..... YES ☐ **NO** ☐
   d) Is the estimated unstimulated absolute open flow potential ≤113 10^3 m^3/day? ..... **YES** ☐ NO ☐
   e) Does the maximum pressure gradient of any formation exceed 10 kPa/m? ..... YES ☐ **NO** ☐
   f) Is there H_2S present (0.0000 mol/kmol H_2S)? ..... YES ☐ **NO** ☐
8. Are there water wells within a 200 m radius of the subject well? ..... YES ☐ **NO** ☐

Certification

I hereby certify that the information given is correct, that it has been provided by personnel taking responsibility for these commitments, and that the requirements set out in Section 3 of *Directive 008* have been met.

Print Name: _____ Title: _____

Signature: _____ Date: _____

ERCB Energy Resources Conservation Board

Directive 008, Checklist 3
Surface Casing Set, Class I BOP Installed

The following checklist must be available at the well site. Supporting documentation confirming that the requirements have been met must be available for auditing purposes. An attached list showing multiple wells must contain the licence numbers, surface locations, surface casing depths, and terminating depths of the wells. Requirements must be met for each well. (Answers in bold indicate requirements.)

Name of licensee: _____ BA code: _____

Contact name: _____ Title: _____

Phone number: _____ E-mail address: _____

Well Licence No.: _____

Surface location of well: _____

Licensed surface casing depth: _____ mKB

1. The well will terminate at _____ m TVD
   (The terminating depth of the well must be less than 1000 m TVD.)

2. Will surface casing be set in accordance with the well licence and will it meet the requirements of *Directive 010*? ..... **YES** ☐ NO ☐

3. Will the diverter line terminate in a flare tank? ..... **YES** ☐ NO ☐
   (Flare tanks must meet the requirements of *Directive 036*, Section 2.4.)

4. Will the well be drilled in an established area? ..... **YES** ☐ NO ☐

5. Is the well located a minimum of 300 m away from an existing SAGD well, or 1000 m away from an existing CSS well or a non-thermal enhanced recovery scheme well? (These distances are closest bottomhole location to closest bottomhole location.) ..... **YES** ☐ NO ☐

6. Regarding the offsetting wells within a 3 km search radius:

   a) Is the kick rate 0%? ..... **YES** ☐ NO ☐

   b) Are there any blowouts (water flows included)? ..... YES ☐ **NO** ☐

   c) Are there are any severe lost circulation incidents? ..... YES ☐ **NO** ☐

   d) Is the estimated unstimulated absolute open flow potential ≤113 10^3 m^3/day? ..... **YES** ☐ NO ☐

   e) Does the maximum pressure gradient of any formation exceed 10 kPa/m? ..... YES ☐ **NO** ☐

   f) Is there H_2S present (0.0000 mol/kmol H_2S)? ..... YES ☐ **NO** ☐

7. Will surface casing be set 25 m deeper than any water wells within a 200 m radius of the subject well? ..... **YES** ☐ NO ☐

Certification

I hereby certify that the information given is correct, that it has been provided by personnel taking responsibility for these commitments, and that the requirements set out in Section 4 of *Directive 008* have been met.

Print Name: _____ Title: _____

Signature: _____ Date: _____